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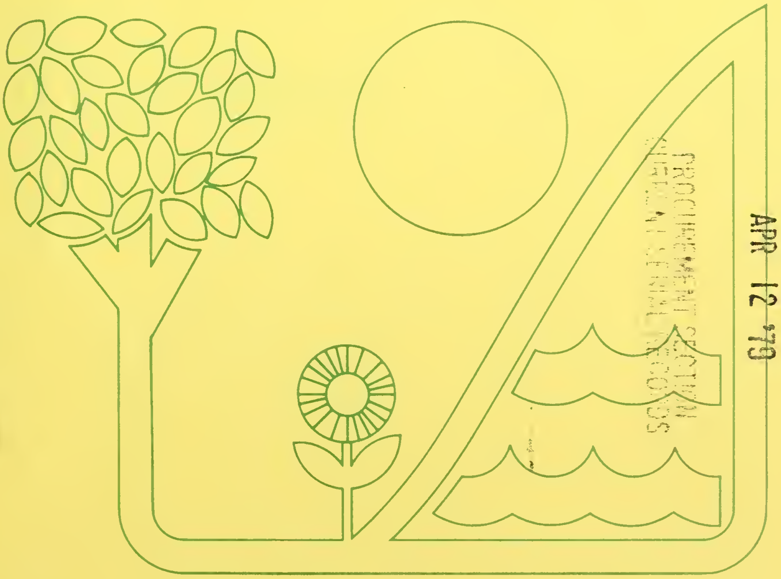

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The Cropland Availability Component
# of the
NIRAP System:
Proposed Revisions

August, 1978

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Introduction

The Cropland Availability Component of the National Interregional Agricultural Projections (NIRAP) system projects changes in the cropland base. Additions to cropland include conversion of pasture and range and forest land, including development of irrigated cropland, while losses of cropland include urban expansion, highway construction, airport construction, reservior development, surface mining, recreation and wildlife reserves, vacation home developments, and loss of irrigated cropland.

A critical review of the component by this author identified two major types of revisions needed. The more important was and still is the inclusion of economic variables in the component. The variables would explain cropland increases and decreases by the economic conditions both on and off the farm. To do this a model of farm level decisions would be used and would likely include opportunity costs of cropland. Utimately the revision would link the Cropland Availability Component with the Land Use Component of NIRAP. Even though some work has been done on the linkage* this revision is viewed as long range.

A more immediate revision involved improvement of some of the sections of the present component. This revision was essentially one of updating the land data base with information from research and surveys completed and data made available since 1969 the most recent year of the data in the component prior to revision. This working paper is the product of that activity.

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*The preliminary work on a model to provide consistent projections of energy demand, energy prices, and agricultural production, has been carried out by Michael Jaske, Clifford Carman, Austin Fox, and Thomas Van Ardsdall of the National Economic Analysis Division, ESCS, USDA.

The task was twofold. First, the cropland data base for each state had to be updated and recreated in a form compatible with the component. This included estimating irrigated and non-irrigated cropland, creating the data base for the increase in non-irrigated cropland, and deriving the cofficients for the urban expansion section.

Secondly, this data base had to be carefully documented as to sources and methods. Lack of detailed documentation of the existing component has made assessment and verification of its coefficients and projections impossible.

This working paper is a replacement for some of the documentation of the component: it includes a new section on the calculation of the cropland base, a section on increase in non-irrigated cropland, and one on the cropland reduction resulting from urbanization section. The revision is a product of recent research results and comparison of different sources of data. It is a significant improvement over the old documentation.

The Cropland Base

In the Spring and Summer of 1977, the cropland base existing in the component was updated from 1969 to 1974. The data source was the U.S. Department of Commerce Census of Agriculture. The Census is published every five years, thus the base should be updated accordingly.

However, the feeling is that the 1974 Census was highly underenumerated, such that it became desirable to use an alternative data source. The 1969 cropland base in the component was thus replaced with the 1974 ESCS Land

Data Base. 1/ This based is also available every five years, corresponding with the Census publication. The ESCS data is provided at the national, regional and state levels, and includes all land uses as well as cropland broken down into its various use components.

One drawback of the ESCS data is the lack of quantities of irrigated acreage. This information is needed to make projections of the irrigated cropland, and nonirrigated cropland from which cropland is taken out of production. A procedure was therefore devised to generate irrigated and nonirrigated cropland acreages, consistent with the 1974 data, for states in which the amount of irrigated cropland acreage is assumed to be significant. The procedure is presented below and the results are shown in Table 1.

1) For each state, the ratio of the 1974 Census cropland to 1974 Census total land in farms was calculated. (1974 Census data used was preliminary.) This percentage was applied to ESCS estimates of total cropland to arrive at an adjusted "land in farms" for each state.

2) For each state, the ratio of irrigated land to land in farms from the 1974 Census was determined. The percentage derived was applied to the above adjusted land in farms, consistent with the ESCS estimate, to calculate an adjusted irrigated land.

3) In Volume IV (Irrigation) of the 1969 Census, Table 6 reports irrigated non-cropland pasture for Class 1-5 farms. The ratio of irrigated noncropland pasture to 1969 irrigated land was found for Class 1-5 farms. This was used as a percentage for the state and applied to the 1969 Census figure for total irrigated land in the state to get the total state irrigated noncropland pasture. This 1969 state irrigated noncropland pasture was substracted from 1974 Census irrigated land to determine the 1974 net irrigated cropland. (The assumption made is that the amount of irrigated noncropland pasture does not change.)

4) The ratio of 1974 net irrigated cropland to 1974 Census irrigated land was determined for each state. The percentage derived was applied to the adjusted irrigated land in (2) to arrive at a 1974 adjusted irrigated cropland.

5) The 1974 adjusted irrigated cropland was substracted from the ESCS 1974 cropland estimates to get adjusted nonirrigated cropland.

6) The 1974 adjusted irrigated and nonirrigated cropland was entered into the component as the 1974 irrigated and nonirrigated cropland base.

An example of the calculations for Kansas are as follows:

Example

1) Kansas

$$\frac{\text{1974 Census Cropland}}{\text{1974 Census Land in Farms}} = \frac{29{,}731{,}000}{47{,}553{,}071} = .6252 = \text{Ratio}$$

$$\frac{\text{1974 ESCS Cropland}}{\text{Ratio 1}} = \frac{31{,}826{,}000}{.6252} = 50{,}905{,}310.3 = \begin{array}{l}\text{1974 Adjusted}\\ \text{Land in Farms}\end{array}$$

2) $$\frac{\text{1974 Census Irrigated Land}}{\text{1974 Census Land in Farms}} = \frac{1{,}988{,}193}{47{,}553{,}071} = .0418$$

50,905,310.3 x .0418 = 2,127,841.97 = 1974 Adjusted Irrigated Lan

3) $$\frac{\text{1969 Irrigated Noncropland Pasture Class 1-5}}{\text{1969 Irrigated Land Class 1-5}} = \frac{6{,}200}{1{,}516{,}724} = .0041$$

1969 Irrigated Land, State = 1,522,377

1,522,317 x .0041 = 6241.50 = 1969 Irrigated Noncropland Pasture, S

1,988,193 - 6241.50 = 1,981,951.5 = 1974 Net Irrigated Cropland

4) $$\frac{\text{1974 Net Irrigated Cropland}}{\text{1974 Irrigated Land}} = \frac{1{,}981{,}951.5}{1{,}988{,}193} = .9969$$

1974 Adjusted Irrigated Land = 2,127,841.97

.9969 x 2,127,841.97 = 2,121,245.66 = 1974 Adjusted Irrigated Cropland

5) 1974 ESCS Cropland = 31,826,000

31,826,000 - 2,121,245.66 = 29,704,754.34 = 1974 Adjusted Nonirrigated Croplan

Table 1. The Cropland Base

Region	1974 ESCS Cropland	1974 Adjusted Land in Farms	1974 Adjusted Irrigated Land	1974 Adjusted Irrigated Cropland	1974 Adjusted Nonirrigated Cropland
Maine	666,000				
New Hampshire	174,000				
Vermont	841,000				
Massachusetts	263,000				
Rhode Island	30,000				
Connecticut	240,000				
New York	5,975,000				
New Jersey	678,000				
Pennsylvania	5,996,000				
Delaware	547,000				
Maryland	1,908,000				
Michigan	8,445,000				
Wisconsin	12,052,000				
Minnesota	23,759,000				
Ohio	12,800,000				
Indiana	14,143,000				
Illinois	25,089,000				
Iowa	28,040,000				
Missouri	20,796,000				
North Dakota	29,695,000	43,669,118	69,871	68,452	29,626,548
South Dakota	20,007,000	47,635,714	142,907	138,391	19,868,609
Nebraska	23,522,000	49,260,733	4,162,532	4,147,131	19,374,869
Kansas	31,826,000	50,905,310	2,127,842	2,121,246	29,704,754

Table 1. The Cropland Base (Continued)

Region	1974 ESCS Cropland	1974 Adjusted Land in Farms	1974 Adjusted Irrigated Land	1974 Adjusted Irrigated Cropland	1974 Adjusted Nonirrigated Cropland
Virgina	4,840,000				
West Virginia	1,616,000				
North Carolina	6,560,000				
Kentucky	9,811,000				
Tennessee	8,545,000				
South Carolina	3,857,000				
Georgia	7,493,000				
Florida	4,154,000	14,348,877	1,685,993	1,378,299	2,775,700
Alabama	5,999,000				
Mississippi	8,711,000	15,670,085	180,206	180,061	8,530,938
Arkansas	10,485,000	16,125,807	1,027,585	1,024,194	9,460,806
Louisiana	5,944,000	9,774,708	732,690	730,932	5,213,068
Oklahoma	15,916,000	36,321,315	566,612	552,560	15,363,440
Texas	38,450,000	142,460,170	6,874,504	6,767,205	31,682,794
Montana	16,035,000	65,235,964	1,793,989	1,624,995	14,410,005
Idaho	6,228,000	14,228,698	2,751,075	2,645,468	3,582,532
Wyoming	2,721,000	34,929,397	1,435,598	1,276,390	1,444,609
Colorado	10,473,000	36,026,832	2,716,423	2,474,389	7,998,610
New Mexico	2,259,000	47,961,783	848,924	820,739	1,438,261
Arizona	1,794,000	44,738,154	1,337,670	1,325,498	468,502
Utah	1,932,000	10,781,250	932,578	827,849	1,104,150
Nevada	763,000	10,931,232	778,303	646,459	116,540
Washington	8,042,000	16,863,074	1,300,221	1,275,127	6,766,873
Oregon	5,045,000	18,272,976	1,557,732	1,432,802	3,612,198
California	11,026,000	34,456,250	7,924,937	7,562,969	3,463,030
Alaska	20,000				
Hawaii	351,000	2,122,128	141,333	138,619	212,381

Land Increase Model

The land increase model is delineated in the old component as:

"$\Delta N_{t-1}^{t} = d_{t-1}^{t} (B_{t-1})$

where:

ΔN_{t-1}^{t} = acreage increase in non-irrigated cropland resulting from resource development between year t-1 and year t.

d_{t-1}^{t} = the proportion of the remaining acreage base (B) shifting to cropland from one year to the next.

B_{t-1} = remaining acreage of pasture and range land in soil capability class/subclass I, IIe, and IIw and in commercial forest classes I and IIe during the previous year. B_{t-1} is obtained by subtracting ΔN_{t-2}^{t-1} from B_{t-2}, i.e.,

$B_{t-1} = B_{t-2} - \Delta N_{t-2}^{t-1}$"

It was assumed that any increase in nonirrigated cropland would be developed primarily from land Classes I-III acreages of pasture and range and forest. 2/ The definition of other land 3/ resulted in the assumption that this use would be a base for very little cropland development. The amount of other land in 1967 was very small in the nonirrigated states delineated by the component. 4/ Most of the Class I land in the relevant regions was already in cropland in 1967. 5/ Of the land capability subclasses, there has been more development on subclass w than on subclass e in the humid areas of the country. Subclass e cropland has been reverting back to forest. 6/

These considerations necessitated a change in the definition of the base for cropland development which presently exists in the component. Currently, cropland is developed from Class I, IIe and IIw pasture and rangeland and Classes I and IIe commercial forest. The base was redefined to include Class III land and subclass w forest for some regions.

Base for Cropland Development

Assumptions were made for each region regarding land classes and subclasses which would be converted to cropland. These assumptions reflect land classes converted in the past, data from the 1967 National Inventory of Soil and Water Conservation Needs (CNI) and the 1975 Potential Cropland Study (PCS), and judgments by knowledgeable persons. 6/

The assumptions and corresponding land classes subclasses were as follows:

REGION	CLASS/SUBCLASS		ASSUMPTIONS
	Pasture & Range	Forest	
Lake States	I, IIe, IIw	I, IIw	Wetlands in the southern part of the region have the greatest potential.
Corn Belt	I, IIe, IIw, IIIe	I, II, IIw	Substantial amounts of erosion-prone land with wetness problems could be developed for cropland. Most of Class III land was already in cropland in 1967 but there remained some IIIe pastureland in 1967 which could be converted.
Appalachian	I, IIw	I	Most of the land with potential for development as cropland is in Virginia and North Carolina, and is located in the coastal plai and tidewater areas.
Southeast	I, IIe, IIw	I, IIw	Over 10 million of the 34.5 million Class I-III noncropland acres in 1967 were woodland prone to erosion. IIe forest was, therefore, omitted.

Delta	I, IIw	I, IIe, IIw	In 1967, more cropland was subclass w than e. Substantial acreages are being developed. Potential cropland is located primarily in the Mississippi Alluvial Valley. Since 1969, there has been some increase in cropland developed from subclass e in the Delta, a reversal of the trend of decreasing cropland on that subclass between 1944 and 1969. It was assumed that the potential subclass e land was Class II forest.
Alaska, Hawaii	I, IIe, IIw	I, IIw	

The assumptions for each region were applied to each state in the region. The 1967 CNI acreages in the above land classes/subclasses became the 1967 base for cropland development. (Table 2)

Land Use Change Data

The 1975 PCS was not designed to be statistically reliable at the state level. Thus, the PCS regional data for land conversion to cropland from 1967 to 1975 was used to develop the coefficients for the proportion of the remaining base shifting to cropland annually.

The 1975 Soil Conservation Service PCS Table 11* of land converted to cropland by regions 1967 to 1975 includes capability Classes I-VIII. Since the component was modeled to assume that only some classes of pasture and range and forest will be converted to cropland in the future, the

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* Unpublished data from Soil Conservation Service, compiled by Linda Lee, USDA/ESCS/NRED, 1977.

Table 2. Base for Cropland Development

State and Region	Acres
Michigan	1,831,356
Wisconsin	2,326,746
Minnesota	1,799,595
Lake	5,957,697
Ohio	1,919,753
Indiana	2,323,259
Illinois	2,846,823
Iowa	2,612,835
Missouri	4,733,347
Corn Belt	14,753,182
Virginia	889,350
West Virginia	134,178
North Carolina	1,055,879
Kentucky	688,959
Tenneesse	952,739
Appalachian	14,436,017
Florida	856,750
South Carolina	1,781,376
Georgia	2,241,590
Alabama	2,012,738
Southeast	6,892,454
Louisiana	5,872,223
Mississippi	4,845,812
Arkansas	4,944,217
Delta	15,662,252
Alaska	14,161
Hawaii	14,140
	28,301

percentages in these classes (depending on the assumptions from above) were applied to the acres converted to cropland from previous uses to determine acreages converted to cropland from each use in the relevant classes. The resulting acreages were summed over the uses to determine the regional acreage converted to cropland 1967 to 1975.

Note that in the Appalachian Region, only Virginia and North Carolina are assumed to have increases in nonirrigated cropland in the future. All states in the region, however, are included in the base for cropland development as they all have some potential cropland. The conversions 1967 to 1975 of Classes I and Iw pasture and range and Class I forest from Table 11 of the PCS, however, are weighted by the percent of the base accounted for by Virginia and North Carolina (26%). Thus, to determine the d_{t-1}^{t} for 1967 to 1980 only the 1967 to 1975 conversions in Virginia and North Carolina are considered. Land use change for the entire United States was used to represent Alaska and Hawaii. The sum of the bases for cropland development, including Alaska and Hawaii, was the national base. The acres converted nationally 1967 to 1975 were calculated for Table 11 PCS assuming Classes 1, 2, and 3 of pasture and range were converted, and Classes 1 and 2 of forest. Then, since Alaska and Hawaii represented only .04% of the base, the conversion calculated above was weighted by .04% to determine the acres converted in Alaska and Hawaii 1967 to 1975.

The calculations and resulting regional acreage of land converted to cropland 1967-1975 are as follows:

REGION	PASTURE and RANGE		FOREST		TOTAL ACRES CONVERTED
Lake	(.29 x 2,236,000)	+	(.38 x 1,163,000)	=	1,090,380
Corn Belt	(.76 x 4,930,000)	+	(.48 x 1,300,000)	=	4,370,800
Appalachian	(.47 x 3,227,000)	+	(.105 x 1,907,000)	=	446,400
Southeast	(.58 x 1,873,000)	+	(.40 x 2,220,000)	=	1,974,340
Delta	(.60 x 1,638,000)	+	(.63 x 2,104,000)	=	2,308,320
Alaska and Hawaii	(.68 x 31,869,000 x .0004)	+	(.35 x 10,955,000 x .0004)	=	10,202

Since the land use change data is one estimate of a two-period change and other time series are not available on cropland conversion, statistical tools such as exponentials, moving averages, Spillman functions, double exponential smoothing etc., to project cropland development, are, not applicable. Instead, the average annual conversion 1967 to 1975 as a percent of the total potential cropland for each region was determined and used as the d_{t-1}^{t} coefficient for each state within the region (with the exceptions of Florida, Mississippi, Arkansas, Louisiana, and Hawaii) and it was assumed that this proportion would continue through 1980.

It was assumed that after 1980, cropland development would decline for all states. This assumption is based on the declining cropland acreage from 1969 to 1974 in all regions except the Southeast and the Delta. It was assumed that by 1980 these two regions would also begin to experience a decline in cropland acreage. The assumption was made that the rate of nonirrigated cropland development varies directly with cropland acreage change, such that after 1980, the rate of cropland development would decline for all states. For all states except those in the Southeast and the Delta, the average annual regional percentage decrease in cropland 1969 to 1974, was used to reduce the d_{t-1}^{t} for 1967-1980 to determine the d_{t-1}^{t} for 1981-2000. This 1981-2000 coefficient was then reduced by the same percentage to determine the d_{t-1}^{t} for 2001-2020. For the Southeast and the Delta region, the national percentage decrease in nonirrigated cropland acreage 1969-1974 was used to determine the d_{t-1}^{t} coefficients for 1981-2000 and 2001-2020 in the above described manner.

Therefore,

$$d_{t-1 \text{ current period}}^{t} = d_{t-1 \text{ previous period}}^{t} - (y \times d_{t-1 \text{ previous period}}^{t})$$

Where:

y = regional (national for the Southeast and Delta) average annual percentage decline in cropland 1969-1974.

Results are in table 3.

Example:

Michigan's 1967 inventory of 1,831,356 in the relevant land capability classes noted above is the (B_{1967}) value.

Thus:

$$\Delta N_{1967}^{1968} = .0228(B_{1967})$$

$$= .0228(1,831,356 - 41,754)$$

$$= \underline{41,754}$$

$$\Delta N_{1968}^{1969} = .0228(1,831,356)$$

$$= \underline{40,802}$$

and for subsequent years

$$\Delta N_{1980}^{1981} = .227(B_{t-1})$$

" "

" "

" "

$$\Delta N_{2000}^{2001} = .0226(B_{t-1})$$

Table 3. d_{t-1}^{t}

Region	1969 Cropland[1] (1000 Acres)	1974 Cropland[2] (1000 Acres)	Percent Decline	Average Annual Percent Decline	d_{t-1}^{t} 1967-1980	d_{t-1}^{t} 1981-2000	d_{t-1}^{t} 2001-2020
Lake	44,332	44,256	.17	.034	.0228	.0227	.0226
Corn Belt	101,969	100,868	1.07	.214	.0378	.0377	.0376
Appalachian	31,630	31,372	.81	.162	.0307	.0306	.0305
Southeast	472,097[3]	466,562[3]	1.17	.234	.0358	.0357	.0356
Delta	472,097[3]	466,562[3]	1.17	.234	.0184	.0183	.0182
Alaska and Hawaii	390	371	4.87	.974	.00002	.000198	.000188

[1] Frey, H. Thomas, Major Uses of Land in the United States: Summary for 1969, AER #247, USDA/ERS , 1973

[2] Ibid., Preliminary Estimates for 1974, USDA/ERS/NRED Working Paper #34.

[3] Ibid, U.S. 1969 and 1974 Cropland.

When comparing this revision to the old model the results of the changes to the "Increase in Nonirrigated Cropland" section of the component will tend to overstate the 1974 NIRAP estimates because of:

1) the difference between the original definitions of the base for cropland development and the proposed definitions, and

2) the higher d^t_{t-1} conversion coefficient of the proposed revision as compared to the original documentation.

The merit of the proposed revision is that it is at least an improvement in documentation of sources of data and reasons for assumptions.

Cropland Reduction Resulting from Urbanization

Current Methodology

Cropland reduction as a result of urban expansion, by state, is determined by the existing component as:

" $U^t_{t-1} = [y(P_t - P_{t-1})] \cdot [l_r]$

Where:

U^t_{t-1} = reduction in cropland acreage resulting from urban growth between year t-1 and year t;

y = coefficient of urban land requirements per capita;

$(P_t - P_{t-1})$ = change in population between year t-1 and year t;

l_r = coefficient denoting cropland's share of total land in the state's consolidated SMSA's, and in simplified form, the reduction in cropland as a result of urbanization is determined as

$$U^t_{t-1} = Z\ (\Delta P^t_{t-1})$$

Where:

$Z = (r)\ (l_r)$

$\Delta P^t_{t-1} = (P_t - P_{t-1})$."

The current methodology includes a population subroutine which assumes that the shares of population of most states remains the same as it was in 1969 with the exception of six states. Examination of state shares over time, however, found that shares in some other states were changing as well. The proposed methodology would allow for changing state shares for any state where appropriate. It should be noted that a new population model is being developed which might replace both the old methodology and the methodology proposed herein.

Proposed Methodology

An urban land use coefficient is a measure of the acreage added to urban areas for a one person increase in the population and is determined by the formula:

$$U = \frac{\dfrac{A_2 - A_1}{T_2 - T_1}}{\dfrac{P_2 - P_1}{T_2 - T_1}}$$

Where:

A_2 = the urban land in a state in the second time period;

A_1 = the urban land in a state in the first time period;

T_2 = the later time period, in this case, 1970;

T_1 = the earlier time period, in this case, 1960;

P_2 = the population of a state during 1970;

P_1 = the population of a state during 1960[10].

The area in urban places data were provided by ESCS 9/, and uses the Bureau of the Census definition of urban, excluding places of 1,000-2,500 population. The ESCS data are "based on area data reported by the Bureau of the Census for urbanized areas and other places 2,500 or more population. Estimates [for different years] are not strictly comparable because of changes in Census definition of urbanized areas and some variation in methods of adjustment by ESCS." 9/

The population in urban places data were taken from the Bureau of the Census, Census of Population. Urban land use coefficients were determined for each state (Table 4). Regionally, the coefficients were lowest for the Northeast (Maine and Vermont were omitted in the calculation because of their high coefficients, which were assumed atypical of the region) and the Pacific, and highest for the Northern Plains and the Mountain regions, with the Delta region third highest.

Note that some of the coefficients are higher than one would have expected 10/. Some of this can be explained by the fact that cropland has been abandoned to grass and woods at a rate more significant than urbanization of cropland. 11/ For example, such states as Maine, New Hampshire, Vermont and Pennsylvania fit this case. Likewise, urbanization in the Delta may have been obsured by new cropland development. 12/ Given these possible problems an alternative was needed for a measure of urbanization's impingement on cropland, an alternative that would give more weight to current (1970) land use.

Inverse Density

Inverse density is the ratio of area to population, in this case acreage in urban places to population in urban places. The 1960 and 1970 densities were calculated for each state. The density developed for incorporation into the cropland availability component as the urban land requirement coefficient y was a weighted sum composed two-thirds of the 1970 density

Table 4. Urban Land Use Coefficients 1960-1970

State/Region	Coefficient	State/Region	Coefficient
Maine	12.85	South Carolina	.59
New Hampshire	1.52	Georgia	.35
Vermont	2.71	Florida	.31
Massachusetts	.44	Alabama	.02
Rhode Island	.38	Southeast	.32
Connecticut	.39		
New York	.20	Mississippi	.81
New Jersey	.22	Arkansas	.56
Pennsylvania	.83	Louisiana	.15
Delaware	.21	Delta	.51
Maryland	.25		
Northeast	.49	Oklahoma	.16
		Texas	.15
Michigan	.31	Southern Plains	.16
Wisconsin	.24		
Minnesota	.33	Alaska	.57
Lake States	.29		
		Hawaii	.40
Ohio	.34		
Indiana	.58	Montana	.69
Illinois	.36	Idaho	.47
Iowa	.24	Wyoming	1.00
Missouri	.59	Colorado	.32
Corn Belt	.42	New Mexico	.66
		Arizona	.28
North Dakota	.40	Utah	.42
South Dakota	.63	Nevado	.44
Nebraska	.33	Mountain	.54
Kansas	.81		
Northern Plains	.54	Washington	.33
		Oregon	.28
Virginia	.38	California	.19
West Virginia	-.25	Pacific	.27
North Carolina	.46		
Kentucky	.41		
Tennessee	.63		
Appalachian	.32		

Table 5. Inverse Density

State/Region	1970 Inverse Density	1960 Inverse Density	Weighted Inverse Density
Maine	.39	.22	.33
New Hampshire	.36	.16	.29
Vermont	.29	.15	.24
Massachusetts	.18	.15	.17
Rhode Island	.18	.16	.17
Connecticut	.21	.18	.20
New York	.10	.09	.10
New Jersey	.18	.17	.18
Pennsylvania	.16	.13	.15
Delaware	.20	.19	.20
Maryland	.15	.12	.14
Northeast	.15	.12	.14
Michigan	.19	.17	.18
Wisconsin	.23	.23	.23
Minnesota	.27	.26	.27
Lake States	.21	.20	.21
Ohio	.21	.19	.20
Indiana	.23	.17	.21
Illinois	.15	.12	.14
Iowa	.28	.28	.28
Missouri	.22	.17	.20
Corn Belt	.19	.16	.18
North Dakota	.22	.17	.20
South Dakota	.26	.22	.25
Nebraska	.28	.16	.24
Kansas	.24	.18	.22
Northern Plains	.23	.18	.21
Virginia	.24	.22	.23
West Virginia	.21	.19	.20
North Carolina	.29	.25	.28
Kentucky	.22	.18	.21
Tennessee	.30	.23	.28
Appalachian	.26	.22	.25

Table 5 Inverse Density (Continued)

State/Region	1970 Inverse Density	1960 Inverse Density	Weighted Inverse Density
South Carolina	.33	.26	.31
Georgia	.29	.28	.29
Florida	.26	.23	.25
Alabama	.32	.36	.33
Southeast	.28	.27	.28
Mississippi	.35	.26	.32
Arkansas	.34	.29	.32
Louisiana	.21	.22	.21
Delta	.27	.24	.26
Oklahoma	.29	.31	.30
Texas	.27	.31	.28
Southern Plains	.28	.31	.29
Montana	.20	.15	.18
Idaho	.27	.23	.26
Wyoming	.24	.19	.22
Colorado	.19	.15	.18
New Mexico	.31	.27	.30
Arizona	.29	.29	.29
Utah	.25	.21	.24
Nevada	.31	.19	.27
Mountain	.25	.21	.24
Washington	.24	.21	.23
Oregon	.23	.21	.22
California	.17	.17	.17
Pacific	.18	.18	.18
Alaska	.32	.16	.26
Hawaii	.19	.13	.17

and one-third of the 1960 density (Table 5). This coefficient was assumed to hold throughout the projection period. (The weights were arbitrary, but were chosen to reflect the importance of the more recent period, while at the same time dampening that situation for the future, giving some significance to the recent past, but not weighting the recent past and current (in this case 1960 and 1970), respectively, equally.) Note that in the Southern Plains the percent population increase was much greater than the percentage increase in urban land, resulting in lower inverse density in 1970 relative to 1960.

State Share of Cropland

The component assumes cropland's share in SMSA's, by state, is constant over time. The shares were developed using 1969 data on state SMSA cropland acreage and 1970 total state SMSA data because these were the two sources most comparable. This data is being estimated for 1974, with data on counties which moved into SMSA's since 1970 and the corresponding acreage changes. As more counties are included in SMSA's, for many regions and states agricultural counties as a percent of total counties in SMSA's is increasing, so that cropland's share in the SMSA is increasing. The projections, therefore, may underenumerate. If, however, the shares in the component are trended up, eventually all cropland would be within SMSA's. Because of these considerations, the assumption of constant shares was utilized for the 55 year projection period. Future modification, when better data are available, should perhaps include a form of growth function to account for additions of counties, and possibly cropland, to SMSA's. A growth function would increase the cropland share at a decreasing rate.

It is assumed that for all regions, except the Delta, any loss of cropland to urban use will result in a reduction of cropland in Standard Metropolitan Statistical Areas (SMSA) only, and that the reduction occurs only from nonirrigated cropland. Most of the regional population increase 1960 to 1970 occurred in SMSA's. In the Delta, however, only a little over 53% of the increase occurred in SMSA's. 13/

For most nonirrigated states the share of cropland in the state's consolidated SMSA's was the ratio of 1969 state total cropland in SMSA's from the Census of Agriculture to 1970 state total SMSA acreage. The calculation of the shares for most nonirrigated states is as follows:

Nonirrigated states

$$l_r = \frac{C_{SMSA_{1969}}}{SMSA_{1970}}$$

Where:

l_r = cropland's share

$C_{SMSA_{1969}}$ = 1969 cropland in SMSA's

$SMSA_{1970}$ = 1970 SMSA acreage.

For Michigan

$$l_r = \frac{2,609,000}{10,664,000}$$

$$l_r = .24$$

If we assume that all reduction occurs on nonirrigated cropland for the irrigated states. Then it is was necessary to weight the cropland in SMSA's in irrigated states by a percentage to determine nonirrigated cropland in SMSA's. In Table 6 of Volume IV titled "Irrigation" of the 1969 Census of Agriculture, the difference between the 1969 irrigated land in

Class 1-5 farms and the irrigated noncropland pasture in those farms can be assumed to be irrigated cropland. The difference between 1969 state total cropland in Class 1-5 farms and the calculated irrigated cropland is 1969 nonirrigated cropland on Class 1-5 farms. The ratio of the Class 1-5 1969 nonirrigated cropland to total Class 1-5 1969 cropland for each state was assumed to hold for the state SMSA's. Thus, for most irrigated states,

$$C_{DRY} = \text{Ratio} \times C_{SMSA}$$

Where:

C_{DRY} = 1969 nonirrigated cropland in SMSA's

C_{SMSA} = 1969 total SMSA cropland

and

$$l_r = \frac{C_{DRY}}{SMSA}$$

Where:

l_r = cropland's share

C_{DRY} = 1969 nonirrigated cropland in SMSA

SMSA = 1970 acreage in SMSA

For Kansas

$$l_r = \frac{844}{3625}$$

$$l_r = .23$$

Thus, the 1969 share of nonirrigated cropland in SMSA's of irrigated states was determined, and was used in lieu of cropland's share in SMSA's.

The Delta states, Wyoming and Hawaii present an exception to the calculations for the irrigated states. As noted above, in the Delta, little more than 53% of the population increase occurred in SMSA's. No SMSA's existed in Wyoming and Hawaii. The 1969 nonirrigated cropland on

Class 1-5 farms was calculated as above for the other irrigated states. The ratio of the Class 1-5 nonirrigated cropland to total Class 1-5 cropland in 1969 was assumed to hold for the state. This ratio was multiplied by the 1969 state cropland to determine 1969 state nonirrigated cropland. The ratio of the state's total 1969 nonirrigated cropland to total land in the state was used in lieu of cropland's share in SMSA's.

Delta states, Wyoming and Hawaii

$$l_r = \frac{C_{DRY}}{A}$$

Where:

l_r = cropland's share

C_{DRY} = 1969 state nonirrigated cropland

A = 1969 state acreage

For Mississippi

$$l_r = \frac{6,551,205}{30,269,440}$$

$$l_r = .21$$

There were also no SMSA's in Vermont and Alaska in 1969-1970. All cropland was thus assumed equally likely to be converted to urban uses in Vermont and Alaska and the share was determined using total state 1969 cropland's share of total state 1969 acreage.

Vermont and Alaska

$$l_r = \frac{C}{A}$$

Where:

l_r = cropland's share

C = 1969 state cropland

A = 1969 state acreage

Table 6. Cropland's Share - Nonirrigated States

State	l_r
Nonirrigated States	
Maine	.04
New Hampshire	.02
Vermont	.14
Massachusetts	.03
Rhode Island	.09
Connecticut	.04
New York	.15
New Jersey	.09
Pennsylvania	.16
Delaware	.20
Maryland	.16
Michigan	.24
Wisconsin	.28
Minnesota	.11
Ohio	.27
Indiana	.34
Illinois	.42
Iowa	.46
Missouri	.27
Virginia	.05
West Virginia	.05
North Carolina	.11
Kentucky	.30
Tennessee	.17
South Carolina	.06
Georgia	.06
Alabama	.11

Table 7. Cropland's Share - Irrigation States

State	1969 Nonirrigated Cropland	1969 Nonirrigated SMSA Cropland	l_r
Irrigated States			
Delta			
Mississippi	6,551,205		.21
Arkansas	6,690,979		.20
Louisiana	3,330,140		.11
Wyoming	669,228		.01
Hawaii	159,501		.03
Other			
North Dakota		827,000	.47
South Dakota		304,000	.37
Nebraska		447,000	.26
Kansas		844,000	.23
Florida		355,000	.03
Oklahoma		921,000	.09
Texas		4,153,000	.10
Montana		516,000	.09
Idaho		41,000	.04
Colorado		459,000	.05
New Mexico		7,000	.006
Arizona		115,000	.006
Utah		113,000	.03
Nevada		6,000	.0004
Washington		341,000	.04
Oregon		360,000	.03
California		1,412,000	.02
Alaska			.00006

For Vermont

$$l_r = \frac{867,000}{5,931,000}$$

$$l_r = .14$$

Summary

This working paper has presented proposed revisions of the Cropland Availability Component of the NIRAP system. The revisions update the data base and improve on the existing documentation. It also changes the definitions of some of the variables of the component.

However, one thing is clear. All projections of the component are only as reliable as the sources of data from which they derive. The section which presents the greatest problem for coefficient development is the "Increase in Nonirrigated Cropland." The reliability of those coefficients depends on a questionable source of land use change data, and on incomplete information about potential cropland in a base year. More work is needed toward the estimation of the coefficients.

Footnotes

1/ Frey, H. Thomas, Major Uses of Land in the United States: Preliminary Estimates for 1974, USDA/ESCS/NRED Working Paper #34, 1977

2/ Frey, H. Thomas and R. C. Otte, Cropland for Today and Tomorrow, USDA/ESCS, AER #291, 1975

3/ USDA.SCS. 1971. Basic Statistics—National Inventory of Soil and Water Conservation Needs, 1967. Stat. Bull. 461.

4/ Frey, and Otte, op. cit., Figure 4, p.11.

5/ Ibid.

6/ Conservation with H. Thomas Frey, USDA/ESCS/NRED, November 1, 1977.

7/ Ibid.; Frey and Otte, op. cit.; USDA op. cit.

8/ Soil Conservation Service, unpublished data, "Potential Cropland Study," compiled by Linda Lee, USDA, ESCS, NRED, 1977.

9/ Frey, H. Thomas, Table: "Area in Urban Places," USDA/ESCS/NRED, provided to the author 6/22/77.

10/ Zeimetz, Kathryn A. et al, Dynamics of Land Use in Fast Growth Areas, USDA/ESCS, AER #325, 1976.

11/ Otte, Robert C., Farming in the City's Shadow, USDA/ESCS, AER #250, 1974.

12/ Ibid.

13/ Ibid. Table 4, p.3.

14/ 1970 state total SMSA acreage data were compiled by Robert C. Otte, USDA/ESCS/NRED.